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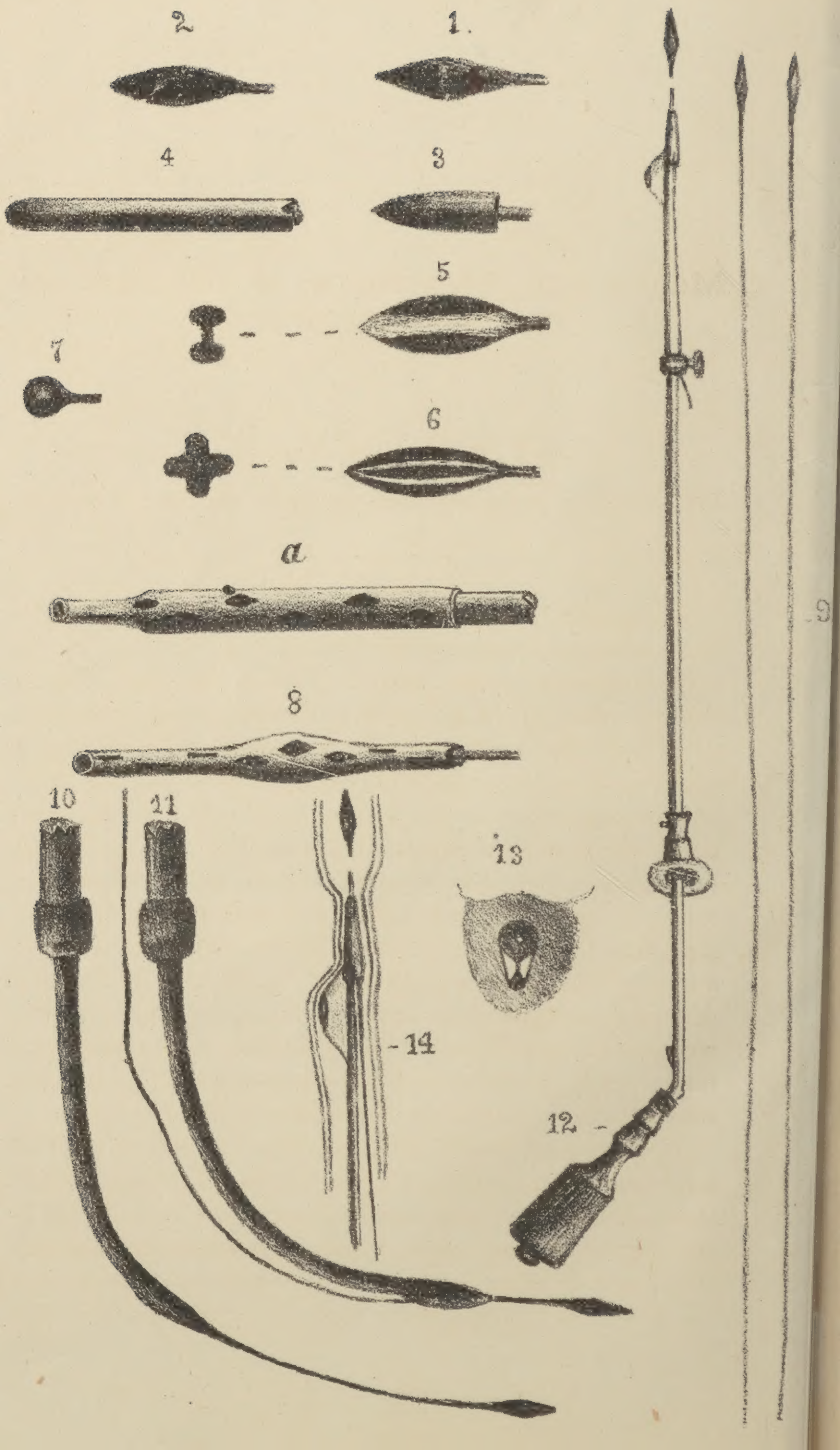
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As the title of this paper implies only a reference to the mechanical department of the treatment of stricture in the urethra, we shall ignore, as far as possible, all other subjects in connection with it, either as to the symptoms, pathology or general treatment, and only refer to them as they may incidentally arise, as specially bearing upon any of the principles and instruments involved or described. Nor have we much that is new or original in the limits of the subject we have chosen, but more especially intend to investigate the causes which render instruments safe and efficient. At the same time hope to place a few of the principles involved in a more philosophical and practicable light, from information derived from experiment and observation, by which several well-known and well-established articles of our armamentorum can be modified and improved so as to further our success in the examination and treatment of stricture.

The situation, length, diameter, firmness, and number of strictures in the urethra, and the pathological changes which these circumstances may originate, are about as uniform in this lesion as in any other requiring instrumental interference; consequently, instruments have been devised to meet the several indications, acting upon principles which are vital

and must always be employed in any that can be invented. Various instruments have been adopted for the accomplishment of rupture, expansion, and the application of caustics, all requiring that the stricture be passed by a staff. We shall desist from describing or commenting upon only such of these as belong to the method and instruments we propose to investigate and describe.

The following headings will include all we shall attempt to describe and illustrate: In texture — solid, metallic, and whalebone. As to pliability — flexible, inflexible, elastic, non-elastic, and a combination of the last two.

These forms always verging according to the situation of the stricture, and to have a bulbous point—its size as small as possible. The obstruction to be passed in every instance by a sound or exploring staff, and all incisions to be made from before backward. When the operation is performed outside of the canal-perinial section, the staff is to be passed through the stricture upon a minute sound, or by having a small flexible metal explorer attached, so as to precede the main instrument. The rapid method of dilatation, the dilator being conducted upon an exploring staff or bougie.

The reasons for advocating the solid instrument are, that no material from which the soft and yielding ones are made will resist the heat and moisture of the urethra, when constructed with sufficient minuteness to admit of its being forced through a narrow stricture with eccentric openings and a tortuous course, and it is my belief, that in those cases where the filiform bougie of Maisonneuve is passed, after great patience and labor, a small metallic instrument would, in most instances, have succeeded in a much shorter time and with greater facility. I am sure that the delicate metallic instrument has succeeded quite readily where the weak flexible one has failed after frequent and protracted attempts had been made by experienced hands. The filiform explorer has many more glaring defects. First, from its extreme pli-

ability, it is almost impossible to detect, in many instances, in stricture seated far back in the canal, whether the instrument is traversing the urethra, or is being folded up in the passage, only to be discovered after it has become impacted to such an extent as to be felt from the exterior of the canal, or when it is withdrawn. We may anticipate that this impaction is going on when the instrument is within the obstruction and passing with difficulty. Its point, perhaps, has already penetrated beyond the stricture, but from the inability to define its true situation, the surgeon withdraws it, suspecting that the resistance in the constricted part is the impacting process, thereby losing what had cost him already much labor, from this inability to define his true position, which, if he could have properly understood, would have led to success. The great advantage claimed for these minute, weak instruments is their not being liable to injure the urethra. While we admit this, we also assert and believe that they are as little capable of accomplishing anything, in a great majority of difficult cases. And we also believe that firm and efficient instruments are sufficiently safe, but that their capabilities necessarily render them susceptible of injury when in the hands of careless and inexperienced manipulators.

The advantages of the solid or metallic instruments are their small size, and power to resist the effects of heat and moisture. When once entered into the urethra, they can be retained there, throughout a whole sitting. Their superior firmness imparts to the touch, both of the operating hand, and the finger externally applied, their true position. They are not subject to be doubled up before a stricture, or when partly within the strictured track. The bending, or diversion from the direction which they were intended to take, is immediately perceptible to the operator, and can be rectified without withdrawing the instrument. When composed of flexible, non-elastic metal, like annealed copper, they can

be easily changed in form by the finger pressing against the outer side of the urethra, and be made to assume any direction the manipulator may desire to give them. Thus they may be made to follow the natural canal, or be aimed against any side or point of its wall at our discretion. In fact, I believe an instrument possessing this quality is the only one which can be rationally and properly employed in that form of stricture where the openings are upon the side of the urethra, often some distance in front of the most constricted part, and which can be only penetrated by carefully examining the sides of the passage. After solid sounds have been introduced, they act as admirable guides to other instruments, either for internal incision, dilatation, or for the relief of the bladder.

The next point, safety, is of great importance, and the one which has had most to do in preventing their general use, for the profession, almost universally, I believe, are inclined to avoid a small, metallic sound, from a fear of injuring the sides of the urethra, or of forming false passages. I advocate that a small sound of flexible metal, with a proper point, is not a dangerous instrument in the hands of any person fitted to conduct an operation upon any case of stricture. These unfavorable impressions have, no doubt, arisen from the accidents that have occurred by injudicious persons attempting to pass strictures of very small calibre with a number one, two or three sound, blindly forcing the instrument against the stricture until it has been bruised or lacerated, and often penetrating the lining of the urethra, forming a new passage alongside of the natural way. If the instrument had been smaller, and of soft flexible metal, these injudicious operators could not have produced such unfortunate effects, but in the hands of a cautious, persevering surgeon, would have been readily passed without injury to the patient. The position may be stated briefly: A staff, as small or smaller than the stricture, its flexibility will give it

advantages by adapting it to the course of the passage, and prevent abuse in the hands of the injudicious. The operator's requirements are, a delicate touch with a persistent, but judicious perseverance.

Small sounds of an elastic material, as tempered steel or whalebone, are often of great service in exploring and passing strictures with tortuous courses, or where more than one exists. From their elastic qualities, the shaft may be made to curve slightly; this throws the force produced upon the extremities of the instrument. It is of a persistent, ever ready to be relieved pressure, and whenever the point of the instrument is introduced within the orifice of an irregular, deviating stricture, this elasticity of the shaft will carry the point through the irregular passage, seeking, as it were, its way of itself, in a manner independent of any direct force from the hand, or guidance from the mind of the operator. In the same way, sometimes, the entrance of the passage can be discovered, and one obstruction after another passed. But it is an expedient, and, like all others practiced upon the urethra, it is subject to abuse, and should not be too harshly applied, or long continued in any one case at a sitting, while in irritable and inflamed strictures, it should be but slightly employed or altogether avoided.

In cases where there were several strictures, with fistulous openings, I have succeeded in effecting a passage with whalebone instruments, with comparative ease, where I had been completely foiled with all others. I may add, that this material is superior, in my opinion, to any substance that has, as yet, been introduced. It is not materially affected by the heat and moisture of the parts; its flexibility is active, but at the same time gentle. The greatest objection is that they are not as safe or capable of acting as directors for the passage of other instruments over them for enlarging the opening to its proper dimensions; yet after they have been once introduced, they act as important indicators of the extent

and direction of the perverted channel, and enable the surgeon to substitute the more appropriate guide, which, without their aid, could not have been introduced.

Inflexible instruments possess greater penetrating powers than the flexible and elastic, but are inferior in their range of application, being only fitted for exploration in the urethra anterior to the bulb. Their rigidity prevents their being sharpened, so as to comply to the course of the diverted passage, consequently the urethra will be compelled to yield to its form, which will cause great pressure to be employed in passing it, and prevents its ready entrance into constriction beyond. Or, when they have been entered, do not enable the surgeon to be certain of the fact, as in the use of flexible sounds, where there is a compromise between the course of the canal and the shape of the instrument, which, in a manner, is made to conform to it. Besides, inflexible instruments are more liable to injure the structures than the flexible, either in the hands of the skilled or the inexperienced. But a combination of these two qualities, the flexible and inflexible, is, in many cases, of great importance in the exploration of strictures in old men, caused by disease of the prostate, or that portion of the passage between it and the bulbous or spongy part. This part of the urethra when diseased is as susceptible to injury as any other, its passage may be as irregular and varying, requiring all the advantages of a flexible instrument to comply with its tortuous and constricted course. But if this flexible property extends throughout the whole length of the instrument, it will be in a number of cases useless, from the inability of the operator to convey its point in any but a forward and backward direction. The curve of the canal and the flexibility of the staff prevent him from directing it against any given point, except by external force, against the perineum or through the rectum. But with a staff of inflexible metal extending down to or beyond the curve beneath the pubis, with flexible

metal extending beyond, composing about one-fourth of the whole length, this will, in a great measure, be obviated, and we have an instrument that is controllable at the will of the operator, and is both safe and effective.

In all explorations for stricture, or for the evacuation of the bladder, strict attention should be given to the curve of the instrument, for nothing is more irrational and impracticable than to attempt to adopt one that will act with equal success upon stricture or obstructions in all sections of the urethra, yet we often see attempts made to accomplish this impracticable feat. Sir Henry Thompson, who has given much attention to this subject, has, after much thought and investigation, adopted a course which he has found to comply with that of the sub-pubic tract in a great proportion of cases. It is the arc of a circle, three and a quarter inches in diameter, the chord of the arc measuring two inches and three-quarters. While this, no doubt, is a proper form for catheters and sounds, to be used when no serious obstruction exists, it most certainly is not the best for explorations in all parts of the urethra, for small and intricate strictures, it being too much curved for that part anterior to the sub-pubic deflection. While it might be proper in some cases beyond that point, in a vast majority of cases, where the obstruction is situated in the prostatic region, especially in old men, it will be found too straight, and the abrupt curve of Bell and Civiale will be more effective.

The form of the point of exploring instruments intended to traverse the urethra in a natural condition, or when contracted and diverted by stricture, is a subject of greatest importance. We have a variety of shapes, all having advocates, proclaiming for each superiority over all others. Among the most prominent, are the cylindrical, conical, bulbous, spherical and knotted. In practice, I have observed the facility with which the bulbous-pointed metallic bougies are propelled through both permanent strictures and the

passage temporarily closed by spasmodic action, and also have heard others remark the same experience, but have never heard any satisfactory reason for this easy introduction. Some explain it by asserting that the urethra contracts behind the bulb and urges it forward, while the anterior portion of the bulb distends and opens the passage before it, so as to enable it to move forward without any obstruction. Others have no explanation, but accept it as a fact, the result of experience. To them, it is a mechanical operation, that performed its duty more easily than others, as many medicines produce beneficial effects, without, at the same time, giving any cause for their results. The cause for the small amount of force required in propelling a bulbous point through the urethra, is readily explained by the simplest laws that govern the effects of friction in all cases; that is, the smaller the surface that is exposed to a given pressure the smaller will be the amount of power required to propel it.

This led me to make several experiments with instruments of different shaped points through an elastic tube, to ascertain the comparative amount of force required by each to propel it through a given space. I constructed a square frame, with two cross-pieces at the top, about two inches apart. Upon the under surface of the lower piece was attached a piece of rubber tubing; immediately above its orifice was a hole through each cross-piece which held steadily the shaft to which the parts were attached, perpendicular to the tube, through which they were to be passed. Upon the upper end of the shaft was arranged a cup, into which a sufficient quantity of shot were placed to force it through the tube. Eight forms of instruments were selected, and all submitted to the same test as near as possible. The circumstance which caused the greatest discrepancy in the experiment was, perhaps, the relaxation of the tube, and the greater ease with which it would permit an instrument to pass after several had preceded it, or the less amount of resist-

ance each instrument encountered than that which preceded it; but this discrepancy was so slight as not to materially affect the experiment as to a correct general result. The forms of the instruments will be readily understood by referring to the accompanying figures.

The first chosen was figure 1, which from theoretic grounds was supposed would meet with less resistance than any of the others. On loading the cup with shot, it was found that fourteen ounces were required to propel it through the tube. The next was figure 2, which most resembled figure 1, but being more conical in form, required one pound three ounces. Figure 3 did not pass until one pound eleven ounces was applied. And a cylindrical sound, figure 4, the same diameter as the others, required two pounds nine ounces to carry it two inches, and when further force was applied by the hand, the tubing was broken from its fastening when it had proceeded four inches and a quarter. A flat instrument, the same length and circumference as those preceding, figure 5, which represents a side and sectional view, required two pounds eight ounces. Before the experiment, I supposed it would move under less weight than any of those experimented with. Another of the same dimensions, formed like figure 6, was propelled by two pounds and about four ounces. A perfect sphere, figure 7, moved under thirteen ounces. I afterwards passed them through an orifice made with a small chisel through a calf's ear, which I fancied might resemble somewhat the character of a stricture, and found that to the hand, the same comparative amount of force was required as in the experiments with the tube. The sphere was not passed satisfactorily, from the great difficulty in introducing it into the small incision. By making a series of small incisions at regular distances and situations, and passing the several instruments, these incisions will become extended. The extent of this expansion, and the number acted upon by each form, exhibits very plainly the com-

parative extent of the tube that is put upon the stretch by each, the one displacing the greatest extent of the tube, will produce the greatest amount of friction, consequently will require the greatest amount of force to propel it. Thus figure 1 distended least, and was carried through by the smallest weight of shot, while figure 4, the cylindrical in form, extended the whole of the tube as far as it advanced, and required the greatest amount of force, which had to be increased as it penetrated. This result is illustrated by figures *a* and 8.

Before the experiment, I supposed that points like figures 5 and 6 would pass with the least resistance, from the small amount of surface exposed to friction, which proved incorrect, these experiments demonstrating that an instrument in passing through a tube in which the pressure is thrown upon a few points or sides is greater than in one where it is equally distributed around its whole circumference, as in figures 1 and 2. Upon examining the inner surface of the tube, I found that where figure 5 was passed a deep indentation was made, condensing and polishing its track. I also observed that in passing figures 1 and 7, that while they passed with about the same amount of resistance, when both were in a perpendicular line with the tube, there was a considerable difference when they were diverted laterally, or diagonally to it, in which position the conical point, figure 1, moved with the greater facility.

Eleven years ago, I commenced the use of whalebone sounds for the exploration of stricture. They were constructed small, and with bulbous points, after figure 2, which I was led to adopt to prevent injury to the parts, and for the purpose of determining the extent and number of the strictures. But the property which first attracted my attention to this material was its elasticity, as I had seemingly succeeded in passing obstructions by this quality with the small gum catheter upon its elastic steel stylet. Another valuable

property was the facility with which it could be made to assume any form after being exposed to the flame of a lamp so as to give it the proper shape, to enable the surgeon to command all parts of the passage. With this instrument I always succeeded in passing a variety of strictures at the City Infirmary, while on duty at that institution.

While in the army, my attention was attracted to the small metallic sound as an explorer and pilot to instruments through stricture in the use of Holt's dilator, when the idea occurred that it was the correct principle, and should be used for the introduction of all instruments for the treatment of stricture, and for the evacuation of the bladder in cases of spasmodic constriction. The disease last mentioned was of quite frequent occurrence in the service, caused by cold and exposure in the field. In many cases, where relief was not attained by rest or opium, the patient suffering great pain, I readily passed a gum catheter—number 8—over a wire with a bulb made of sealing-wax. After the wire was introduced, the catheter was passed over it, a hole having been made in its lower extremity for the introduction of the guiding wire, which passed up alongside of the stylet; the catheter and stylet were then steadily pressed along over the wire till it reached the constricted part, when it was forced through the resisting space with little difficulty or danger to the parts, the stylet and wire withdrawn, and the urine evacuated. Since then I have dilated the constriction with the dilator over an explorer, and then passed the catheter.

These observations and experiences led to the preceding investigations and experiments. The two together have suggested a few instruments constructed upon the principles they have presented to me. For an exploring sound for all parts of the urethra: A minute wire staff, represented by figure 9, of soft, flexible metal, silver, annealed copper, iron, or brass, polished, or coated with untarnishable metal; the

size not being larger than No. 4, French scale, bulbous point, formed of two cones united at their bases, the apex of one for the point of the instrument, the other attached to the shaft; its greatest diameter about as thick again as the shaft. For explorations of the posterior parts of the urethra, beyond the sub-pubic arch, in difficult cases: A staff of the same size as that just described, the anterior three-fourths of which is composed of firm, tempered metal, the remainder of soft, flexible material, the same as the other instrument. This forms a safe, controllable instrument, where the one of flexible material throughout its whole length would be inefficient.

Great difficulty is often experienced in passing the sound in perinial section, although that portion which enters and occupies the stricture in Symes' instrument, is usually smaller than the other part of the staff anterior to it, its size and form often renders its introduction extremely difficult. To obviate this, I have adopted two expedients. The first, figure 10, is a staff of steel, the usual form down to a point, where Symes' instrument is diminished and grooved, at which point I add an extremity, about as long again as in his staff, composed of soft annealed copper. At the point of juncture between the two metals is a bulb, increasing the diameter about two lines; this acts as a guide to the upper part of the stricture, which is often difficult to detect with Symes' staff, in cases where there is a great thickening of the parts. The superior half of the copper extremity is the usual dimensions of the instrument of Syme, except the lower half inch is larger, by not being made flat, as the remainder above it is, on the convex side. The remaining half, below this round half inch, diminishes in size abruptly until it is of the size of No. 4, French scale, except the point, which is terminated by the bulbous point like figure 1. This is a staff, mounted by a permanent explorer, which can be changed in form to act in any direction, and be passed

through strictures with ease. The half inch that remains round expands the constriction so that the diminished flattened portion passes more readily, and at the same time give an idea of the extent of the stricture.

The other instrument, figure 11, is of the same material as this first, and of the same forms, except that it has not the terminal explorer. But through the end of the copper extremity, which is of the same size and shape as the upper half of the copper appendage of the first instrument, is a small orifice proceeding up a short distance and escaping upon the convex side, as in the exploring staff of Van Beuren. Through this orifice the small exploring wire is passed, it having already been passed through the stricture, and the staff is made to follow it through the constriction.

For increasing stricture, our instrument is, in a manner, a modification of Maisonneuve's; yet it differs from it in many important particulars. His requires that a staff of considerable size should first be passed, which in difficult cases is not a favorable instrument for exploration, although armed with the filiform appendage. In the use of our instrument, the stricture is first passed by the minute exploring sound, which acts as a guide to the incising blades. Figure 12 illustrates its various parts. It is composed of a handle and shaft of steel, the latter being one-fourth of an inch in diameter. Upon the lower surface of the shaft is a groove, running its whole length; into this groove runs the shaft of the incisor, which is attached posteriorly to a movable piece with a projecting rim, by which the shaft and incisor is projected forward and backward in the groove; it is held into the groove at the lower end of the shaft by a ring, which is retained in its place by a thumb-screw. After the exploring wire or staff is passed through the stricture, it is conducted through the guide of the incisor, and then placed into a small groove upon the upper side of the shaft, beneath the ring, and immediately under the screw,

which also retains it firmly in its position. The incisor is upon the same principle as Maisonneuve's. The guide, through which the exploring shaft passes, is placed above and in front, and is largest, immediately opposite the cutting end of the incisor. The incisor has a cutting edge only in front, and has a blunt under side, which acts as a dilator to the incised stricture. The guide is made larger opposite the cutting edge, in the first place, to hold the urethra away from the sharp surface laterally; and again, to place the stricture, when it has entered it, upon its utmost tension, so as to be incised more readily. Figure 13 is a sectional view of the instrument within the urethra, illustrating how the sides are held from the cutting edge as it advances through the unobstructed passage. Figure 14 represents the guide within the stricture and the cutting edge commencing the incision. If a very small exploring sound is employed, it is best to detach it from under the screw, when the incisor is withdrawn from the urethra, as it may double up and injure the passage, but if it be of the size of No. 4 and ordinarily firm, it can be withdrawn without this precaution.

For expansion or rupture without incision, a shaft with a conical bulb can be substituted for the incisor, and be made to pass over an exploring wire or bougie, as with the other instrument. It acts and is constructed upon the same principle as the dilator recently introduced in this country from Paris.

With our present experience, the cases which most properly belong to the incision, are those that are very sensitive and occupy a considerable length of the urethra, and are narrow and firmly constricted, and probably those cases where more than one stricture exists. Those in which dilatation is the most suitable operation, are where there is a tolerance of instruments, a stricture of but small extent, and of an expansible character, and those situated in the posterior portion of the passage.